CLAIMS

What is claimed is:

1. A radio frequency power transistor having a collector, a base, an emitter, a first output, and a second output, the radio frequency power transistor comprising:

a first transistor having a first electrode coupled to the collector of the radio frequency power transistor, a control electrode coupled to the first output of the radio frequency transistor, and a second electrode;

a first resistor having a first electrode coupled to the base of the radio frequency power transistor and a second electrode coupled to the first output of the radio frequency transistor;

a second resistor having a first electrode coupled to said second electrode of said first transistor and a second electrode coupled to the emitter of the radio frequency power transistor;

a second transistor having a first electrode coupled to the collector of the radio frequency power transistor, a control electrode, and a second electrode coupled to the emitter of the radio frequency power transistor;

a third resistor having a first electrode coupled to the base of the radio frequency power transistor and a second electrode coupled to the second output of the radio frequency power transistor; and

a fourth resistor having a first electrode coupled to the second output of the radio frequency power transistor and a second electrode coupled to said control electrode of said second transistor.

2. The radio frequency power transistor of claim 1 further including:

a plurality of transistors wherein each transistor of said plurality of transistors has a first electrode coupled to the collector of the radio frequency power transistor, a control electrode coupled to the base of the radio frequency power transistor, and a second electrode; and

a plurality of resistors wherein each resistor corresponds to a transistor of said plurality of transistors and wherein each resistor has a first electrode coupled to said second electrode of said corresponding transistor of said plurality of transistors and a second electrode coupled to the emitter of the radio frequency power transistor.

3. The radio frequency power transistor of claim 2 wherein said first transistor, said second transistor, and said plurality transistors are substantially equal.

4. The radio frequency power transistor of claim 3 wherein the radio frequency power transistor operates where an emitter current I_e is substantially equal to $(\beta + 1) * I_b$ where β is a transistor current gain and I_b is a base current before an onset of avalanche breakdown.

5. The radio frequency power transistor of claim 4 wherein each resistor of said plurality of resistors has a resistance $R/(\beta + 1)$.

6. The radio frequency power transistor of claim 5 wherein said first resistor has a resistance value equal to said fourth resistor.

7. The radio frequency power transistor of claim 6 wherein said third resistor and said fourth resistor combine to have a resistance equal to R.

8. The radio frequency power transistor of claim 7 wherein a first difference voltage is produced across the first and second outputs of the radio frequency power transistor under normal operating conditions when the radio frequency power transistor is not producing a substantial impact ionization current.

9. The radio frequency power transistor of claim 8 wherein a second difference voltage is produced across the first and second outputs of the radio frequency power transistor when an impact ionization current is produced at an onset of avalanche breakdown and wherein said first and second difference voltages are not equal.

10. A method for detecting an onset of avalanche breakdown in a radio frequency power transistor, the radio frequency power transistor comprising a plurality of transistor cells coupled in parallel, the method comprising the steps of:

operating the radio frequency power transistor in a range where an emitter current I_e of the radio frequency power transistor is substantially equal to $(\beta + 1)I_b$ where I_b is a base current and β is the current gain of the radio frequency power transistor; and

detecting the onset of avalanche breakdown when the radio frequency power transistor no longer operates under a relationship where I_e is substantially equal to $(\beta + 1)I_b$ due to impact ionization multiplication.

11. The method as recited in claim 10 wherein said step of operating the radio frequency power transistor further includes a step of operating each transistor cell of said plurality of transistor cells substantially equal.

12. The method as recited in claim 10 wherein said step of detecting the onset of avalanche breakdown further includes a step of monitoring an increase in impact ionization current as the radio frequency power transistor approaches the onset of avalanche breakdown.

13. The method as recited in claim 10 wherein said step of detecting the onset of avalanche breakdown further includes the steps of:

providing a first transistor cell of said plurality of transistor cells having an emitter ballast resistor;

providing a second transistor cell of said plurality of transistor cells having a base ballast resistor wherein said first and second transistor cells; and

comparing operation of said first and second transistor cells.

14. A radio frequency (RF) power amplifier having an input and an output comprising:

an inductor having a first terminal coupled for receiving a first power supply voltage and a second terminal coupled to the output of the RF power amplifier; and

a radio frequency power transistor having a collector coupled to the output of RF power amplifier, a base, an emitter coupled for receiving a second power supply voltage, a first output, and a second output wherein a first difference voltage is generated across said first and second outputs when said radio frequency power transistor is not subject to avalanche breakdown and wherein a second difference voltage is generated across said first and second outputs at an onset of avalanche breakdown in said radio frequency power transistor.

15. The radio frequency (RF) power amplifier as recited in claim 14 further including:

an input stage having an input coupled to the input of the RF power amplifier and an output;

a capacitor having a first terminal coupled to the output of the input stage and a second terminal coupled to said base of said radio frequency power transistor;

a bias circuit coupled said base of said radio frequency power transistor;

a comparator having a first input coupled to said first output of said radio frequency power transistor, a second input coupled to said second output of said radio frequency power transistor, and an output; and

a protection circuit having an input coupled to said output of said comparator and an output coupled to the input of the RF power amplifier.

16. The radio frequency (RF) power amplifier as recited in claim 15 wherein said protection circuit is disabled when said first difference voltage is generated across the first and second outputs of said radio frequency power transistor and wherein said protection circuit is enabled for reducing an input signal applied to the input of the RF power amplifier when said second difference voltage is generated across the first and second outputs of said radio frequency power transistor.

17. The radio frequency (RF) power amplifier as recited in claim 14 wherein said radio frequency power transistor comprises a plurality of transistor cells and includes a first transistor cell having a base ballast resistor and a second transistor cell having an emitter ballast resistor.

18. The radio frequency (RF) power amplifier as recited in claim 17 wherein said first transistor cell of said radio frequency power transistor comprises:

a first resistor having a first terminal coupled to said base of said radio frequency power transistor and a second terminal coupled to said first output of said radio frequency power transistor;

a second resistor having a first terminal coupled to said first output of said radio frequency power transistor and a second terminal; and

a transistor having a collector coupled to said collector of said radio frequency power transistor, a base coupled to said second terminal of said second resistor, and an emitter coupled to said emitter of said radio frequency power transistor.

19. The radio frequency (RF) power amplifier as recited in claim 18 wherein said second transistor cell of said radio frequency power transistor comprises:

a first resistor having a first terminal coupled to said base of said radio frequency power transistor and a second terminal coupled to said second output of said radio frequency power transistor;

a transistor having a collector coupled to said collector of said radio frequency power transistor, a base coupled to said second output of said radio frequency power transistor, and an emitter; and

a second resistor having a first terminal coupled to said emitter of said transistor of said second transistor cell and a second terminal coupled to said emitter of said radio frequency power transistor.

20. The radio frequency (RF) power amplifier as recited in claim 19 wherein said radio frequency power transistor further includes a plurality of transistor cells and wherein each transistor cell of said plurality of transistor cells comprises:

a transistor having a collector coupled to said collector of said radio frequency power transistor, a base coupled to said base of said radio frequency power transistor, and an emitter; and

a resistor having a first terminal coupled to said emitter of said transistor and a second terminal coupled to said emitter of said radio frequency power transistor.